



## **OPTICAL SEMICONDUCTORS, INC.**

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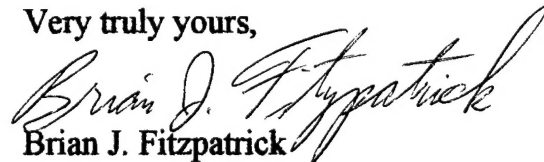
October 8, 1997

Dr. Yoon Soo Park  
Program Officer  
Office of Naval Research  
800 North Quincy Street  
Arlington, VA 22217-5660

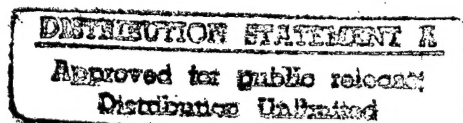
Dear Dr. Park:

This is the first report on Contract N00014-97-C-0367, "Hexagonal II-VI Structures by Substrate Bandgap Engineering". Also included are the DD250 forms, used as an invoice, and the SF298 form, the "Report Documentation Page".

Very truly yours,

  
Brian J. Fitzpatrick

cc: Anna M. Weston,  
Administrative Contracting Officer  
Program Manager, ONR  
Director, Naval Research Laboratory  
✓ Defense Technical Information Center  
Ballistic Missile Defense Organization



## Hexagonal II-VI Structures by Substrate Bandgap Engineering

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A synthesis procedure was developed for bulk ZnMgSSe, using metallic Mg and Se. This is done in the growth crucible in the growth system; this reduces contamination from exposure to the laboratory ambient.

A growth run with 12% Mg and 8% S (nominal) concentrations was done using our zone melting technique in a non-seeding crucible. A  $45^\circ$  cross-section was made by cleaving; it appeared that one grain was about half of the 26 mm (average) diameter boule. No twins were visible at all. It is, of course, desirable to have twin-free material, but, even more importantly, the lack of twins is a strong indication of hexagonal material, a major goal of the program.

Cleavage was facile, with a small number of steps. The maximum size of a facet so far was about 6 x 12 mm;  $45^\circ$  dihedral cleaves (prisms) were seen.

UV-lamp stimulated photoluminescence (PL) was quite uniform, both on the surface and in transmission, although some scattering of transmitted light was seen. PL stimulated by a He-Cd laser (325 nm) on a cleaved sample at 77K showed dominant near-band-edge emission, consisting of both excitonic and donor-acceptor pair transitions; a small amount of deep level emission was seen. The position of the excitonic peak allowed an estimate of the band gap ( $E_g$ ) to be made. At 77K, it was about 2.96 eV; if the same temperature dependence of  $E_g$  as that of ZnSe is assumed, the room temperature gap would be about 2.86 eV.

Conductivity was indicated with a VOM, without deposited contacts. This procedure was done for ZnSe, and the results were checked by Hall measurements, which confirmed a conductivity of 4.65 ohm-cm for ZnSe.

X-ray examination showed sharp reflections in a  $2\theta$  scan. The Cu  $K\alpha$  doublet was split, with a modulation depth of 84%. Further analysis is in progress.

Etching and surface preparation procedures (in- and ex-situ) were studied, using both ZnSe and ZnMgSe. Molecular-beam-epitaxial growth of ZnSe on ZnSe was achieved, with rocking curve widths of 21-24 arcsec.

Short-term plans are to grow material of both lower and higher magnesium concentrations, and to get the 12% boule fabricated into substrates for MBE growth.

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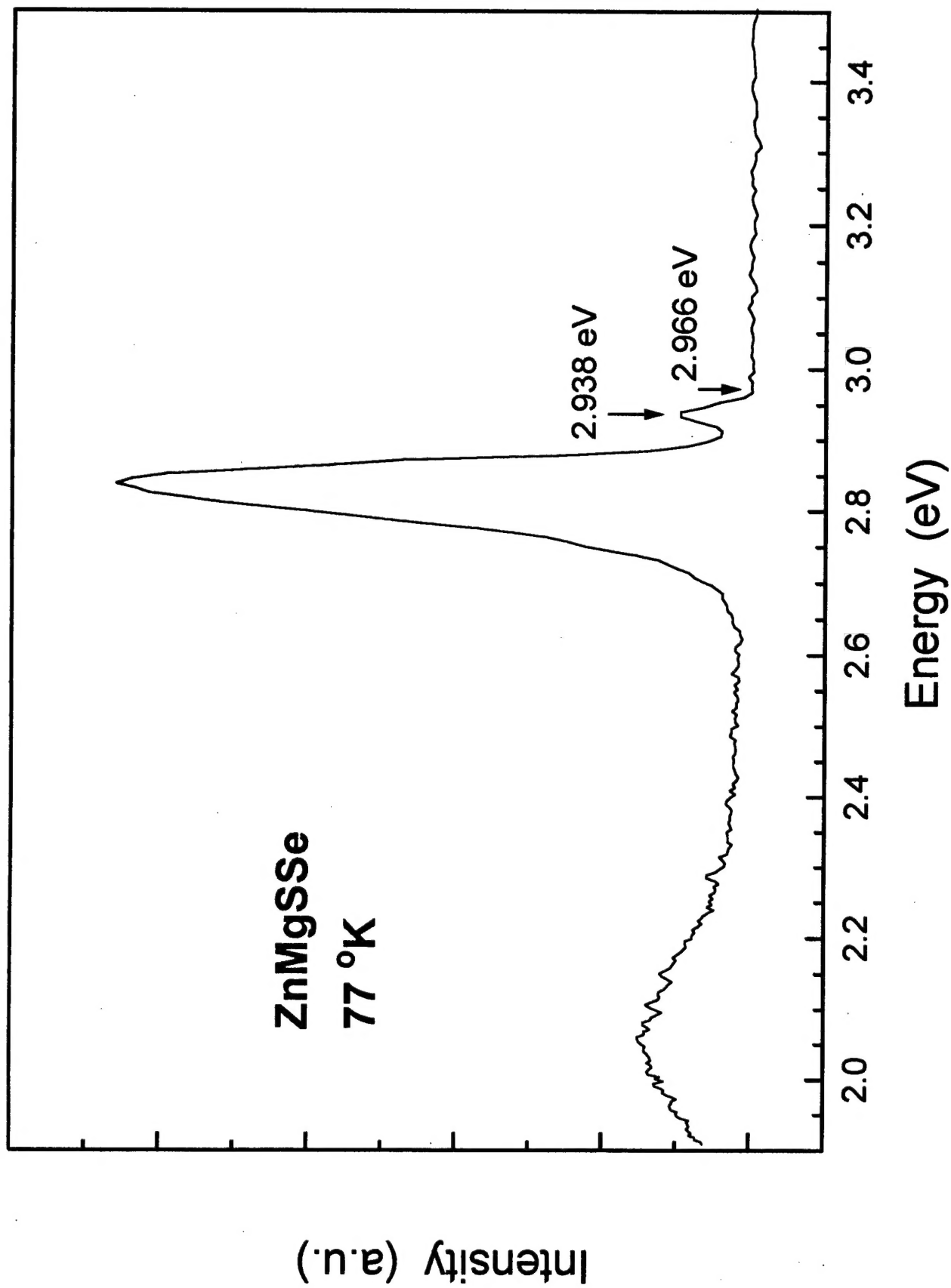


Diagram 1. Photoluminescence of ZnMgSSe. The upward shift of the band gap from ZnSe is clear; the quality is at least comparable to that of good ZnSe.

ID: ZnMgSSe (30kV, 10mA)  
File: ZNMGSSE4.MDI Scan: 15-110/02/1/#4751, Anode: CU

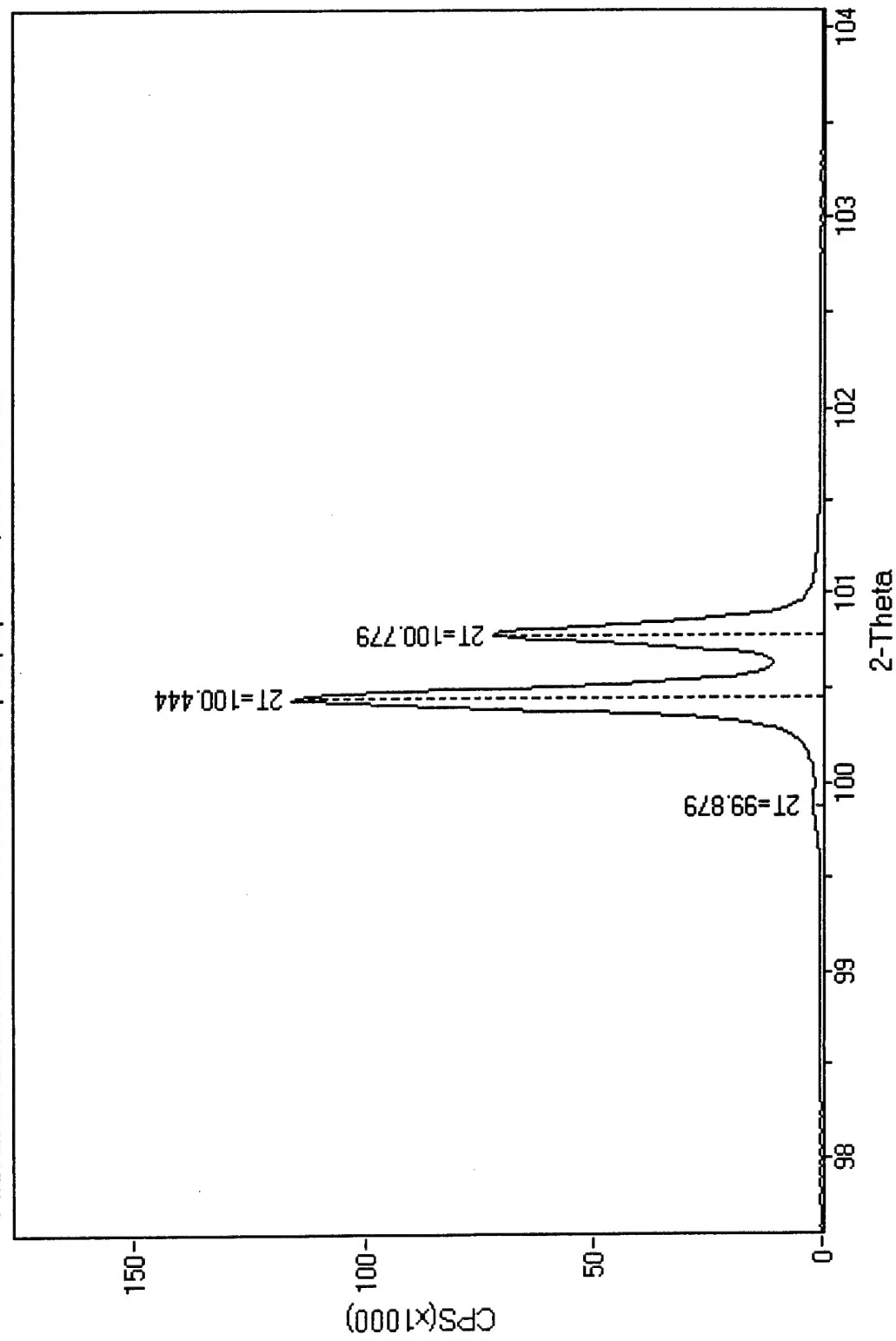


Diagram 2. Portion of x-ray scan of (1120) cleaved face of ZnMgSSe. The 84% modulation depth is measured from the smaller peak.